REVIEWS.

MODERN IDEAS OF DERIVATION.* — This felicitous title heads an equally expressive and concise summary of the various theories on the origin of species, treated by the strong hand of an accomplished and veteran observer.

Professor Dawson recognizes that Darwin has given form and coherency to researches upon the origin of species, but omits one very important consideration, to which we think the greatest effect of his book is due. The novel and exact methods of investigation, the analytical character of the book powerfully influenced a much larger class of minds than those who heartily accepted the theory of a struggle for existence. The doctrine of natural selection may or may not be true, but the mode of study which it inaugurated began a new era in the history of natural sciences and is already producing results of great value.

The author begins his review with Professor Owen, but succeeds no better than his predecessors in the same field, and is forced finally to deduce his opinions from the oracular manner in which that distinguished anatomist writes of certain animals as being "made," "formed," or "brought forth." Professor Huxley gets a well deserved and very sarcastic notice for his late attempt to prove the theory of derivation by "a series of cleverly arranged transitions," between some of the larger fossil reptiles (Iguanodons) and the ostriches. "Yet," writes Professor Dawson, "he could not have placed together any two members of the supposed series without convincing any naturalist that an enormous gap had to be filled between them." The views of Darwin are summed up as follows: "That all organized beings are engaged in a struggle for existence; that in this struggle certain varieties arise, which, being better suited to the conditions, prosper and multiply more than others: that this amounts to a 'Natural Selection,' similar in kind to the artificial selection of breeders of stock; that members of the same species isolated from each other and subjected to struggles of different kinds, will in process of time become specifically distinct."

Professor Dawson objects to this theory for several reasons. The most important are that "conditions which involve a struggle for existence are found by experience to result in deterioration and final extinction rather than improvement, and are directly opposed to those employed by breeders for their purposes," and that the possibilities of geological history are exceeded by the enormous time demanded by Darwin for accomplishing the developmental change from one species to another.

Seemingly no worse or more contradictory comparison could be made

*Modern Ideas of Derivation. By Principal J. W. Dawson, LL. D. Canadian Naturalist, Vol. iv, No. 2. June, 1869.

than that between the laws which govern the transmission of characteristics among races perpetually clashing in the "struggle for existence," and those influencing the production of different breeds among animals enjoying the protection of the animal breeder. We, however, think that Professor Dawson would find it difficult to establish the truth of this very important proposition, that the conditions involving a struggle for existence necessarily lead to extinction. Darwin himself has shown that it leads to the extinction of those races which are not possessed of certain advantages, and that it cannot according to physiological laws do otherwise than develop in a higher degree those points or changes in the favored races which enabled them to gain their first victories over their weaker brothers.

The last objection, with regard to the lapse of time demanded for specific changes according to the Darwinian theory, is becoming stronger every day. Deep sea dredgings have shown us that computations of geological time, based upon the thickness of rocks, and the presence of different assemblages of animals or faunæ in successive beds are not to be relied upon. These explorations have detected the presence of very distinct faunæ dependent upon changes of temperature, and very different rocks in the course of formation within comparatively narrow limits. Thus it no longer becomes necessary to account for the change from one fossil fauna to another, as we pass from one stratum or bed to another in geological time, by imagining the lapse of ages and a corresponding modification of the organization of the animals included in the lowest bed. A simple change of fourteen degrees Fahrenheit may possibly make the difference between a limestone composed entirely of organic remains, and a sandstone containing the fossil remnants of a totally distinct fauna, though both of these may have been composed of contemporaneous animals.*

The author's remarks upon Professor Cope's late paper before the American Association so well expresses the substance of the new theory of derivation that we quote them in full:

"The last of these hypotheses which I shall notice, and, in my view, the most promising of them all, is one which has recently been ably advocated by Mr. Edward D. Cope in a memoir on the 'Origin of Genera,' published in the Proceedings of the Academy of Natural Sciences,† and which is based on the well known analogy between embryonic changes, rank in the zoological scale and geological succession. It may be illustrated by the remarkable and somewhat startling fact, that while no authenticated case exists of animals changing from one species to another, they are known to change from one genus or family to another, and this without losing their individuality. Professor Dumeril, of Paris, and Professor Marsh, of New Haven, have recently directed attention to the fact that species of *Siredon*, reptiles of the lakes of the Rocky Mountains of Mexico, and which, like our North American *Menobranchus*, retain their gills during life, when kept in captivity in a warmer temperature than that which is natural to them, lose their gills, and pass into a form hitherto regarded as of a different genus and family,—the genus *Amblystoma*. In this case we may either suppose that the Amblystoma, under unfavorable circumstances, has its maturity and reproduction prematurely induced be-

*See Recent Explorations of Deep Sea Fauna, by A. E. Verrill. American Journal of Science and Art, 2d series, January, 1870.

†Philadelphia, 1869.

fore it has lost its gills, or that the Siredon has, under certain circumstances the capacity to have its period of reproduction arrested until it has gone on a stage farther in growth and has lost its gills. In any case the same species—nay, the same individual—is capable of existing in a state of maturity as a creature half fish and half reptile in regard to its circulation, or in a more perfect reptilian state in which it breathes solely by lungs. Farther, we may suppose conditions of the earth's surface in which there would only be Siredons or only Amblystomas, and a change in these conditions inducing the opposite state. Here we have for the first time actual facts on which to base a theory of development. These facts point to the operation of two causes—first, the possible *Retardation* or *Acceleration* of development, and secondly, the action of outward circumstances on the organism capable of this retardation or acceleration. We here substitute for the tendency to vary of Owen's theory, the ascertained fact of reproductive retardation or acceleration, and for the struggle for existence, the action of changed physical conditions, and for the question as to the change of one species into another, the change of the same species from one genus into another. Farther, instead of vague speculations as to possible changes of allied animals, we are led to careful consideration of the embryonic changes of the individual animal, and as to the differences that would obtain were its development accelerated or retarded. We can thus range animals in genetic series within which anatomical characters would show change to be possible. I cannot follow these series out into the elaborate lists tabulated by Mr. Cope, but may proceed to notice the limitations which his views put to the doctrine of derivation. It is obvious that, if this be the real nature of derivation as a possible hypothesis, then derivation must follow the same law with metamorphism and embryonic development.

According to this view, also, a species once created may have in itself a capacity for passing through several generic forms, constituting a cycle which ever tends to return into itself, or to advance and recede by steps more or less abrupt under the law of retardation and acceleration, combined with the influence of external circumstances. Yet the dimensions of the orbit of each species must be limited, its duration in time must also be limited, and its capacity to pass into a really new species must still be a point subject to doubt, but open to anatomical investigation and inference. As already hinted, it is a most important point of this theory, that when we have ascertained the series of embryonic changes of any animal, we have thereby ascertained its possibilities in regard to accelerated development. Its possibilities in regard to retarded development may be inferred by similar studies of animals higher in the scale. Now, if we knew the embryonic history of every animal, recent and fossil, in its anatomical details, we should be able to construct out of this a table of possible affiliation of animals, and should be able to trace our existing species through the same genera, families, orders and classes in which they might have existed in geological time, and to predict what they might become in time still to come."

This theory of acceleration we have also shown to be the law of growth* among the Nautiloids and Ammonoids. Thus the discoidal Nautili, though an ancient group, do not accomplish during their entire life, from the Silurian to the Tertiary, such extensive changes in the septa as the Clymeniæ do in the course of a single geological epoch, the Devonian. Each species of this group adds something to the serial complication of the lobes and cells of the sutures until from a species *Clymenia lævigata*, inseparable generically from the Nautiloids, there is produced a species, *Clymenia pseudogoniatites*, which is a true Ammonoid.

This last species presenting itself to the geologist suddenly according to the usual action of the law of acceleration, has young with lateral lobes, and an internal siphon like the other Clymeniæ, but both the young and adult have the abdominal lobes and superior lateral cells of an Ammonoid, as well as the more involute whorls of that order. This case is precisely parallel to that of the growth of the Siredon salamander into

* On the Parallelism between the Different Stages of Life in the Individual and those in the entire Group of the Molluscus Order, Tetrabranchiata. By A. Hyatt. Memoirs Boston Society of Natural History, Vol. 1, Part 2, 1867.

an Amblystoma, and presents itself to the geologist when compared to the lower Clymeniæ in the same way, the only difference being that in this case the characteristics of a different order of animals are produced by the acceleration of the growth, instead of a distinct family and genus merely.

Other instances are brought forward in the memoir referred to above which show the action of the law of acceleration, when applied to different species, and since then other observations have been made which demonstrate with equal clearness the agency of the law of acceleration in the production of varieties and even of individual differences.

Thus one of the best known species of the Lower Lias, *Asteroceras* (Ammonites) *obtusum*, is divisible into several varieties. For the sake, however, of reducing it as much as possible we will eliminate all of these but three, and consider only the English specimens from one locality, Lyme Regis. These have three distinct variations of form. The first has the ordinary rounded sides and abdomen, with very broad immature keel and exceedingly shallow channels, while the *pilæ* (costæ) are prominent and round off evenly at either end. The channels appear on the last quarter of the third, and almost immediately attain their ultimate adult depth and aspect on the fourth volution; the second has the same peculiarities in the larger number of individuals, but accelerates them by adding to the depth of the channels and the height of the keel after the fourth volution, producing thereby adults with deeper channels and more prominent keels. There are different degrees of this acceleration in different individuals, some having shallower channels than others.

The third variety attains the adult characteristics of the most advanced members of the second variety on the fourth whorl, and on the fifth, flattens the sides. The first and second varieties have gibbous or rounded sides, but the third is a transitional variety, approximating to *Asteroceras stellare*. The accelerations show themselves also in the development of the pilæ; the second variety ceasing to be smooth and beginning to form these lateral projections at an earlier age than the first, and the latter forms the same parts at an earlier age than in the first variety.

This whole progress in the form and characteristics of parts takes place by individual accelerations. Thus in the first variety we have certain individuals which remain smooth longer than others which nearly equal the rate of growth observable in the second variety, but are retained in the first by the slower development of the keel and channels. An objection may and probably will be made to this view, that the third is really a variety of *Asteroceras stellare*, and does not belong to *Asteroceras obtusum* at all. This alternative would be even more favorable to the theory here advanced than that given above. The difference is less in all respects between the third variety described above and the unquestionable *Asteroceras obtusum*, than between the former and *Asteroceras stellare*. Therefore any estimation of the value of their characteristics which would join the third variety to the latter species must also include the former

species as a variety under the same name. If at the other end of the series we should be permitted to add *Ammonites Turneri*, which we think will perhaps prove to be merely a local variety of *A. obtusum*, the evidence becomes additionally strong. This variety, or species, has only the faintest marks of channel grooves, even upon the first quarter of the sixth volution, both upon the shell and upon the cast, and in the typical *Turneri* the pilæ at this age run nearly to the base of the keel. The septal proportions and outlines of the lobes and cells are the same as in the typical *Asteroceras obtusum*, and in all respects it is similar to that species, differing only in the later or slower production of the channels and keel and in its somewhat smaller size.

A third opinion that all of these were distinct species, may be answered first, by reference to the accelerations in the development of the pilæ occurring between the different individuals of the first variety, which in that case become types of varieties, and, also, by citing other species. Thus one species of a lower genus *Arnioceras incipiens*, all the specimens of which are from one locality, fades by regular and inseparable gradations from specimens whose whorls possess no channels in the adult to those which have these parts better defined even at an early age than in the adult of the third variety described above. This position might also farther be strengthened by showing that this presence or absence of channels becomes in the Middle Lias of such importance that it constitutes a generic distinction in the family group (*Hildoceratidæ*) which is nearest allied to that which includes the species referred to above, the family of *Discoceratidæ* (*Arietes*). Thus *Hildoceras* (*Ammonites bifrons* and *Walcottii*) differs from *Grammoceras* (*Amm. striatulus*, *Amm. Aalense*, etc.) principally in these characteristics.*

The presence or absence of channels, therefore, or any change of form to which the abdomen may be subjected, cannot, to use the terms of the modern systematist, be considered as of slight importance even though we find them, when first introduced, subject to simple varietal changes in some species.

The limits of a review do not permit us to continue this part of the subject. Leaving many similar instances, therefore, to appear in due course of publication, we will pass on to the consideration of the application of the theory to another series of facts. We refer to the changes which take place during the old age of the individual and also of the group. They bear directly upon that portion of Professor Dawson's remarks which refer to the possibility of determining beforehand the future course of the changes of a group, but have been accidentally passed over in silence by him. He has also given Professor Cope the undivided credit of discovering the law of acceleration, whereas the memoir we have referred to above, which has escaped Professor Dawson's notice, will remove all doubt that the aim of a large part of the investigations there

* Bulletin of the Museum of Comparative Zoology, No. 5, p. 99.

recorded is identical with those of Professor Cope's more elaborate essay. We have no desire for controversy and regard scientific claims as generally speaking not worth contending for, but feel that silence, in the present instance, would place in a false light the object of these investigations, and vitiate the original value of the results of much labor not yet published. The quotation below will serve to justify these remarks, and at the same time bring us back to the more agreeable and legitimate subject of this review.

"This law" (of acceleration) "applied to such groups as have been mentioned, produces a steady upward advance of the complication. The adult differences of the *individuals* or species being absorbed into the young of succeeding species; these last must necessarily add to them by growth, greater differences which in turn become embryonic, and so on; but when the same law acts upon some series whose individuals alter the shell in old age, precisely the reverse occurs, and a general decline takes place. The old age characteristics in due course of time or structure, become embryonic and finally affect the entire aspect of the higher members of the series."* In other words there are certain degradational characteristics first found in the old age of the shell, which are inherited at earlier periods by species standing higher in the series, just as the adult characteristics are inherited by them in the young. Thus the degradation and ultimate extinction of groups of animals may be accounted for by the law of acceleration quite as accurately as their rise and progress in organization.

These degradational tendencies bring about in the old age of the individual quite a close resemblance to its own young,† and in the group their inherited influence may be traced to its ultimate results in the peculiar unrolled shells of the Cretaceous Ammonites, which are, form for form, the same as those of the earlier Nautiloids in the older formations. In other respects also the aberrant Ammonoids of the Cretaceous may be shown to be degraded species; in their simpler septa when compared with the normal formed ammonites, having in the adult only the six lobes of the young, and in their ornamentation, and simple, rounded, keeless and channelless whorls.

Thus the retardation of development which is invoked to account for the tendency of species to return to forms analogous with those with which they began; or, in other words, to complete cycles either as a series or in geological time, becomes only another phase of the law of acceleration. The very complete analogy, to say the least, which exists between the life of a group and that of an individual member points very decidedly to some law that governs alike the growth and decline of the individual and the group to which it may belong. The struggle for existence may, and probably does as well as physical circumstances strongly influence the action of this law, but that it has no controlling influence is

* "On the Paralellism," etc., p. 232.

† First noticed by D'Orbigny. Pal. Francaise. Terr. Cretaces p. 381.

proved, we think, by the fact that degradational or senile tendencies are inherited.

In this connection I would suggest that the Turrillites and other allied spiral shells, will ultimately be found to be the legitimate descendants of the deformed Turrillites described by D'Orbigny from the Lower Lias beds. It is now generally acknowledged by European writers that these forms are discoidal ammonites that have departed from the usual mode of growth common to their species, and instead of revolving always in the same plane the whorl has become slightly assymetrical, and thus begun to form the assymmetrical spiral of the genus Turrillites. This tendency is quite common with the septa of *Psiloceras psilonotus* and other species, and in the shell, also, but is so faintly expressed that it is difficult to distinguish from the effects of compression. If this and other instances of a similar kind be finally substantiated we have here still another application of the law of acceleration to characteristics, which naturalists have been hitherto accustomed to call deformities.

According to the theory of natural selection only favored races can prolong their existence by perpetually inheriting the advantages of their ancestors, and certainly the degradational characteristics as displayed in all the terminal species of the ammonoids cannot be explained in this way. Here also we have the limitation of the cycle of changes or variations, of which a species or form may be supposed to be capable, at least partially accounted for; and as Professor Dawson and others have pointed out, the theory of natural selection makes no provision for such restrictions. Reversion cannot be called upon to explain the return of the Nautiloid forms in the Ammonoids of the Cretaceous, because they show the effect of traceable inherited characteristics continually augmenting in force, and because these are senile to the group, and are no more reversionary than the old age of the individual is a reversion to its own younger state. They are accomplished by methods opposed to the metamorphoses occasioned by the progress of the group in structure and by growth in the individual. They take place by a gradual suppression or atrophy of the adult characteristics in the individual, and in the group, by an unrolling of the closely coiled and deeply involute whorl of the Jurassic Ammonites, and they occupy the polar extreme of structure and life in both cases.

We would remark, in conclusion, that Professor Dawson does not wholly commit himself to the new theory, but regards it as "holding forth the most promising line of investigation" as yet advanced. Though the author of the theory in common with Professor Cope, we cannot refuse to endorse Professor Dawson's judgment as regards this decision also. The law certainly explains much which has been hitherto inexplicable, but until the extent to which it may be modified by physical causes, and perhaps natural selection, be fully understood, an unprejudiced mind cannot consider it as capable of clearing away all our present difficulties. It gives us, perhaps the means of asserting that the plasticity of organs

have certain limits; that variations can arise from natural selection, or physical changes, only when these act in given directions and for a given time, after the expiration of which, whether in the individual or the group, if sudden death do not intervene, all changes must be degradational in character. Physical causes, and the struggle for existence can no longer improve the vitiated organization when it has passed this period. Its death is decreed as certainly as its line of developmental changes must have been before it was born, and whatever agency other laws may have, they can only act with more or less force and velocity in these predetermined paths of progress and decline, or cut them short by the destruction of the organization. — A. HYATT.

THE TORREY BOTANICAL CLUB, which, under the auspices of its President and Nestor, meets at the Herbarium in Columbia College, began with the year to issue its "Bulletin," in monthly numbers of four pages each. The notices and memoranda thus issued relate chiefly to the local flora of New York, which is the special charge of the Club; but matters of more than local interest are touched upon, making it well worth the attention of our botanists throughout the country. For example, in the February number, Mr. Leggett, the editor, explains the anomaly of *Lepidium Virginicum* having accumbent cotyledons, contrary to all the rest of the species, showing that what may be termed the petioles of the flat cotyledons, in line with the radicle, and in which the bend is made, are in the position answering to incumbent, and so the cotyledons take the accumbent position by a twist of ninety degrees. The "Bulletin" is furnished, upon application to the editor, 224 East Tenth street, New York, for a dollar a year, or seven copies for five dollars.

FOSSIL PLANTS FROM THE WEST.* — This report closes Dr. Hayden's report reviewed by us in March, 1870. By some oversight we confused it with a former paper of Professor Newberry, and thus passed by some of the most important results of the explorations. The first portion is a general review of the geology of North America, and as these government reports, notwithstanding their wide distribution, generally have but few non-scientific readers, we shall republish this for the benefit of our subscribers in some succeeding number.

The chapter on the "Cretaceous Flora" gives a concise summary of the various government expeditions which have made collections of the plants of this period. The conclusions reached are identical with those which we have already quoted in the review referred to above in March, 1869, page 41.

Among the Miocene plants Dr. Newberry finds *Onoclea sensibilis*, a species undistinguishable either from the living forms of this species or those found in Europe, only on the island of Mull, off the west coast of Scotland. This and the large number of other identical miocene species, lead to the inference that North America and Europe were connected by

* Report on the Cretaceous and Tertiary Plants. By Professor J. S. Newberry.